RUMINATING ABOUT DEPRESSION AND SELECTIVE ATTENTION

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RUMINATING ABOUT DEPRESSION AND SELECTIVE ATTENTION

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LIST OF SYMBOLS AND ABBREVIATIONS

SA	Selective Attention
Rum	Rumination
Dep	Depression
RTS	Ruminative Thought Style Questionnaire
RRS-R	Reflection Subscale of the Ruminative Responses Scale
RRS-B	Brooding Subscale of the Ruminative Responses Scale
RRS-D	Depressive Subscale of the Ruminative Responses Scale
CESD-R	Center for Epidemiological Studies Depression Scale Revised
C	Congruent
I	Incongruent
N	Neutral
S	Sad
H	Happy
NP	Negative Priming
NNN	Neutral flankers and target
SNS	Sad flankers and neutral target
HNH	Happy flankers and neutral target
CS	Congruent sad trial
IS	Incongruent sad trial
CH	Congruent happy trial
IH	Incongruent happy trial

SUMMARY

Depression is a debilitating mood disorder that has been linked to ruminative thinking. Clinical research has found connections between rumination, depression, and deficits in selective attention, especially for negative emotional material. However, results are inconsistent, especially regarding the role of ruminative thinking. In this context, rumination is usually operationalized as ineffective, intrusive, repetitive thinking about the symptoms, causes, and consequences of depression. However, Brinker and Dozois (2009) proposed that rumination forms a more general construct, independent of depression, but the relationship among this global rumination, depression, and selective attention has received little examination. The current study used a latent variables framework to analyze how emotional and non-emotional selective attention tasks relate to depressive symptoms, as measured by the CESD-R, and to both general rumination and rumination as a coping mechanism for depression. All forms of rumination formed a coherent construct, which could not be isolated from depressive symptoms as measured by the CESDR. Selective attention, regardless of item valence, was predictive of neither rumination nor depressive symptoms in the current study. Additionally, only non-emotional Stroop and the emotional and non-emotional Flanker tasks had acceptably high reliability, while the rest of the included selective attention tasks were quite unreliable.

CHAPTER 1

INTRODUCTION

Depression is a major mood disorder, distinguished by prolonged negative affect and persistent feelings of worthlessness and powerlessness. A large body of research has linked depression to ruminative thinking. The most frequent operational definition of rumination is that of Nolen-Hoeksema and colleagues, who have defined rumination as a style of thinking in which a depressed or dysphoric individual responds to their negative mood by focusing on their symptoms and the potential causes and consequences of these symptoms in a repetitive, passive, and uncontrolled manner (Nolen-Hoeksema, 1991; Treynor et al., 2003; Nolen-Hoeksema et al., 2008). Here, rumination is a style of responding to depressed mood, characterized by a passive, repetitive focus on depressive symptoms, as well as on the possible causes and consequences of these symptoms. Such ruminative thinking can compound and prolong depressive episodes, presumably by impairing problem solving, disrupting constructive behavior, and reducing social support (Nolen-Hoeksema, 1991; Nolen-Hoeksema et al., 2008).

Depression usually features deficiencies in memory and attention, and may be compounded by ruminative thoughts flooding a depressed individual's attention. Additionally, those prone to rumination may encounter difficulty selecting effective approaches to problem solving, instead fixating on ineffective approaches (Nolen-Hoeksema et al., 2008). Specifically, Joormann and colleagues (Joormann, 2004, 2006, 2010, Joormann & Gotlib, 2008), have tied depression, and in some cases rumination, to deficits in inhibition for emotional material. The primary finding is that there is an

inhibitory deficit for negatively valenced emotional material in the presence of depression and rumination. However, how these emotionally valenced tasks compare to their original non-emotional variants is unclear. This thesis will investigate, in a principled manner guided by current literature on inhibitory processing and interference control, how rumination, depression, and inhibitory functioning relate for both general and emotion-specific material. Furthermore, this thesis will assess how emotional selective attention tasks correlate with their non-emotional ancestors.

Ruminative Responding and Depression. Nolen-Hoeksema and colleagues (Nolen-Hoeksema, 1987, 1991, 2000; Nolen-Hoeksema & Morrow, 1991, 1993; Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; Lyubomirsky & Nolen-Hoeksema, 1993; 1995) have found extensive evidence tying rumination to depression. The dominant self-report measure of rumination is probably the ruminative responses scale (RRS; Nolen-Hoeksema & Morrow, 1991), an abbreviated version of the response styles questionnaire (RSQ). The RRS is a self-report measure of how frequently an individual engages in 22 thoughts or behaviors in response to depressed feelings (Nolen-Hoeksema et al., 2008). A ruminative response style, as assessed by the RRS, has been found to mediate the relationships between risk factors for depression and future major depressive episodes. Spasojević and Alloy (2001) conducted a 2.5-year study of 137 initially nondepressed individuals, assessing depression, rumination, and additional risk factors for depression. They found that during the 2.5-year follow-up period, rumination mediated the relationship among negative cognitive styles, self-criticism, neediness, and history of past major depressive episodes and subsequent major depressive episodes.

While the RRS ostensibly measures rumination, many of its items explicitly refer to depression. Treynor, Gonzalez, and Nolen-Hoeksema (2003) tried to purge the RRS of items blatantly similar to items in the Beck Depression Inventory (BDI). Factor analysis revealed two factors in the remaining items: reflection and brooding. Reflection was defined as a "purposeful turning inward to engage in cognitive problem solving to alleviate…depressive symptoms," while brooding was defined as "a passive comparison of one's current situation with some unachieved standard" (Treynor et al., 2003). In a longitudinal study using the RRS, Treynor and colleagues (2003) found that brooding was positively related to depression in both the short- and long-term, while reflection was positively related to depression in the short-term, but was negatively related to depression in the long run.

Likewise differentiating brooding and reflective rumination, Joormann, Dkane, and Gotlib (2006) showed that currently depressed individuals have higher overall brooding scores relative to other individuals. Formerly depressed and socially anxious individuals did not differ in brooding, but both scored higher on brooding relative to healthy controls. Only currently depressed individuals and healthy controls differed in reflection. Brooding also remained elevated after recovery from a depressive episode, and was "particularly strongly associated with depressive symptoms, with cognitive biases and, thus, with sustained negative affect in depression". Using a dot-probe task [see below], the authors also found that brooding was more strongly associated with cognitive biases than was reflective pondering. In light of this all this, it would seem that brooding is almost always maladaptive, while reflection may ultimately be (comparatively) helpful.

Global Rumination. As has been previously noted, the ruminative response style theory of rumination restricts rumination to a coping mechanism for dealing with depressive or dysphoric symptoms. According to Brinker & Dozois (2009), rumination must be operationalized independently of affective valence in order to study it at a broader level than in the context of depression. To do this, they developed the Ruminative Thought Style Questionnaire, which measures the ruminative tendencies in the absence of depression-laden items, resulting in a single-factor measure with high internal consistency. Relative to the RRS, the RTS appears to address a more global ruminative thought style. In a 3-week longitudinal study, the RTS was predictive of negative mood at both the beginning and end of the observed time period, even after controlling for baseline depressed mood (Brinker & Dozois, 2009). Brinker and Dozois proposed that rumination rehearses the thoughts held online in focal attention, transferring them from working memory to long-term memory. Since these thoughts are now more active in long-term memory, they are in turn more accessible to working memory, creating a loop that encourages their recurrence.

It is unclear how the single, general rumination factor tapped by the RTS relates to the reflection and brooding subscales of the RRS, which are likely more strongly associated with depression and dysphoria. If the degree of control over attention is what separates reflection from brooding, then presumably individuals with loosely controlled attention should be more likely to engage in brooding/depressive rumination, while those with tighter control should be more likely to engage in reflective rumination. As such, the global rumination observed by Brinker & Dozois (2009) should show similar correlates

to the reflective pondering subscale identified by Treynor et al. (2003), while the brooding subscale should behave differentially.

Inhibitory Deficits in Rumination and Depression. Several tasks have been used to assess the relationship among depression and rumination and inhibitory dysfunction. Some of the most prominent are the emotional Stroop (1935) task, the dot probe task (MacLeod, Mathews, & Tata, 1986), negative priming (Neill et al., 1995), and an "Ignore/Suppress" task (Nee & Jonides, 2008). Most often, researchers using these tasks in the context of the study of rumination and depression have used emotional/affective stimuli rather than the more emotion-free stimuli used for the 'standard' versions of these tasks.

Emotional Stroop. The basic idea of the Stroop task is that words, or nonwords, are presented to participants, who are required to name the color in which the stimuli are displayed. This task is particularly difficult when a color-naming word is presented in a conflicting color, such as *BLUE* appearing in yellow. Stroop interference is generally observed as slowed response times for these incongruent trials, relative to congruent or nonword stimuli.

The emotional Stroop effect refers to a response time slowing when naming the color of emotionally-laden words relative to emotionally neutral words (Gotlieb and McCann, 1984), so it is not directly analogous to the traditional Stroop effect, which is based on contrasting response times for congruent and incongruent color stimuli. In spite of this difference, both paradigms suffer from a difficulty in isolating the source of their respective effects. Gotlib, Yue, and Joormann (2005) argue that it is "virtually impossible" to isolate the source of Stroop interference, as it could be due to input processes, output processes, or both input and output processes.

Another, and perhaps more substantive, problem with the emotional Stroop task is that its relationship with depressive mood may not be as robust as one would hope. Peckham, McHugh, and Otto (2010) conducted a meta-analysis of 29 studies that used either emotional Stroop or the Dot-Probe task to assess inhibitory dysfunction in clinically and nonclinically depressed samples, as well as in samples with induced negative mood. They found that the emotional Stroop effect was only marginally significantly different for depressed versus nondepressed individuals, whereas the Dot-Probe task was significantly different for these populations.

Research by McKenna and Sharma (2004) and Frings, Englert, Wentura, & Bermeitinger (2010) suggests that the absence of an overall effect of emotional Stroop for depressed individuals compared to those not suffering from depression could be due to differential effects based on the source of Stroop interference within the tasks. They distinguish between a "fast" and a "slow" effect. The fast effect occurs when emotional stimuli capture attention automatically and immediately, within a single trial. The slow effect is the emotional interference of the previous trial on the current trial (McKenna & Sharma, 2004). Manipulating the sequence of negative and neutral trials influences the appearance of these two effects, and can even reverse the observed emotional Stroop effect. Specifically, a truly random sequence produces the expected fast effect but masks the slow effect, which should only be evident on consecutive trials with different emotional content (McKenna & Sharma). Ultimately, Mckenna and Sharma found evidence for the existence of the slow effect in emotional Stroop, but did not find evidence for the traditional fast effect. However, a recent study by Frings et al. (2010) produced evidence supporting the presence of both a fast and a slow effect in emotional Stroop.

Frings et al. (2010) utilized a version of the emotional Stroop task featuring neutral and negative words. In their design, they insured that current trials were uncorrelated with their immediate predecessor trials; this allowed them to examine the fast and slow effect separately. They found response time evidence for both the fast and slow effect, but did not find either effect to be significant using error data. In short, the emotional Stroop effect is jointly explained by a fast, within-trials effect, and a slow, across-trials effect. Decomposing the emotional Stroop in this way may be more useful, as previously it was difficult to isolate the source of the effect (Gotlib, Yue, & Joormann, 2005; MacLeod et al., 1986).

Dot Probe Task. The other most widely used measure of inhibitory dysfunction in the literature, according to Peckham et al. (2010), is the dot probe task (MacLeod, Mathews, & Tata, 1986). In the dot probe task, two stimuli are presented simultaneously on the screen; following the presentation of the stimuli, a probe (in the form of a dot) appears in the location of one of the two previously presented stimuli. The participant's task is to indicate the location of the dot with a corresponding keystroke. The dot probe task frequently uses emotionally laden stimuli, and the measure of interest is the difference in response times for probes following negative and (generally) neutral stimuli (Peckham et al., 2010). In their meta-analysis of 22 studies (9 dot probe studies for a total of 12 dot probe tasks), Peckham et al. (2010) found that depressed participants reaction times differed significantly from nondepressed participants on the dot probe task. Joormann et al. (2006) included a dot probe paradigm in their study, and found that an attentional bias for negative faces correlated with the brooding subscale of the RRS, but not to the reflection subscale.

Negative Affective Priming. Perhaps the most prominent attentional inhibition measure in the current clinical literature is Joormann's (2004, 2006) negative affective priming (NAP) task. The NAP task is a standard negative priming task, except for the inclusion of emotionally valenced material. In the NAP task, participants are usually required to identify the emotional valence of the target stimulus, generally a word (Joormann, 2004). Emotionally valenced words are presented in paired prime and test trials. In the negative priming condition, distractors in the prime trial and targets in the test trial share the same emotional valence. In the control condition, the prime trial distractors are unrelated to the test trial targets. Joormann (2004) showed that currently and formerly depressed individuals displayed an inhibitory deficit specifically for negatively valenced words. Joormann (2006) used a similar NAP design, and found that ruminative tendencies were closely related to inhibitory dysfunction for material that is irrelevant, emotional, and self-referential, be it positively or negatively valenced. Joormann (2006) suggested that dysphoria may be specifically related to inhibitory deficits for negative information, while rumination may be related to a more general inhibitory deficit for both negative and positive information. However, the experiment did not include a neutral condition, which would provide stronger evidence of a general deficit. Goeleven et al. (2006) employed an NAP paradigm using happy and sad faces as stimuli. They examined never-depressed individuals, patients who were hospitalized with major depression, and formerly depressed individuals. They found that never-depressed controls showed no inhibitory deficits, while currently depressed individuals showed impaired inhibition of negative stimuli and normal inhibition for positive material. Formerly depressed individuals were impaired at inhibiting both positive and negative stimuli. Surprisingly, Goeleven et al. did

not find a relationship between inhibitory deficits and ruminative thinking. Joormann and Gotlib (2010) used another NAP task and found results that were generally congruent with previous studies, mainly that currently depressed individuals showed reduced inhibition for negative material. Zetsche and Joormann (2011) conducted a study that used two NAP tasks, one with words and one with faces, as well as an emotional flanker task. The two NAP tasks were intended to assess control of interference due to internal representations, while the emotional flanker task was intended to assess control over interference from external material. They assessed depressive symptoms and rumination in an initial session and then again 6 months later. In the initial session, both NAP tasks were related to depression, but neither was related to rumination. However, at the 6-month follow-up, the NAP tasks were predictive of rumination and depression. Confusingly, the emotional flanker task was related to rumination during the initial session, but was not associated significantly with depression. Joormann, Nee, et al. (2010) and Joormann and Gotlib (2008) both found evidence that rumination is related to how well individuals are able to discard irrelevant information from working memory. Berman, Nee, et al. (2011) used a directed-forgetting style paradigm and found that individuals diagnosed with depression, relative to controls, were worse at removing negative, but not positive, information from working memory. They also found that discarding negative information from working memory was related to rumination, possibly more to brooding than reflection.

When considered together, these studies indicate that depression seems to be associated with deficits in controlling access to working memory, but rumination's role is less clear and consistent. Overall, there is reasonable consensus that depressed mood is associated

with an attentional bias for negative material. Whether or not this is strictly limited to negative material is unclear.

Non-emotional Inhibition. Although much of the research on inhibitory function in the face of depression and rumination has been conducted using emotionally-valenced stimuli, there is some evidence of an effect with neutral material. Altamirano, Miyake, and Whitmar (2011) examined two executive control tasks, letter naming and Stroop, in the presence of rumination and dysphoria. They used the RRS to assess rumination and the BDI to assess dysphoria. They found that higher ruminative tendencies (both reflection and brooding) predicted lower accuracy on letter naming, whereas higher ruminative tendencies predicted better accuracy on rare incongruent trials in their Stroop task (which featured 25% incongruent and 75% congruent trials). Dysphoria had a negative effect on performance of the Stroop task, even though dysphoria was positively related to rumination. The authors argue for a differential relationship between rumination and dysphoria regarding goal maintenance. Higher rumination promotes better goal maintenance, whereas higher dysphoria promotes worse goal maintenance. These findings suggest that there may be a more general relationship between inhibition, dysphoria, and rumination. Therefore, it should be informative to examine how rumination and depression relate to one's ability to ignore, or inhibit, irrelevant information, be it emotionally charged or neutral, by selectively attend to relevant information.

The Current Study. Given the divided and debated definition of inhibition, I have chosen to frame inhibition in terms of interference control, which, based on the research discussed above, relates to working memory capacity and the control of attention. Within

this framework, the current study examined how depression, global rumination, and coping rumination are both interrelated and related to interference control of non-emotional, sad, and happy emotional material. Based on the discussion above, more acute depression should correlate positively with higher rumination, particularly brooding, as well as to increased interference, particularly from mood congruent (i.e., sad) stimuli. Rumination is, essentially, a difficulty with regulating the content of one's thoughts. Therefore, rumination, as a whole, should correspond to a general difficulty regulating interference. More specifically, depressive ruminators should experience the most interference from mood congruent, emotionally sad, stimuli. If global rumination is a coherent construct, and we successfully sample non-depressive ruminators, we expect these individuals to experience higher interference overall, rather than merely from material with specific emotional valence.

CHAPTER 2

METHODS

Participants. A total of 255 participants, aged 18 to 35 years, were recruited from the undergraduate student population at the Georgia Institute of Technology. After removing those who performed below chance on any of the eight selective attention tasks, 222 participants remained in the sample. Of these, 148 showed no signs of depression (scores less than 16 on the CESD-R), while 75 showed evidence of depressive symptoms (scores greater than or equal to 16 on the CESD-R). Participants received either course credit or payment for their time.

Materials, Design, and Procedure. Testing took place in a single session, lasting approximately 3.5 h. All participants completed all survey items and computer-administered tasks in the same order to minimize error from participant-by-order interaction, as the data were analyzed using a latent variables framework. First, participants completed a battery of paper-and-pencil survey measures, beginning with the RTS and the RRS rumination measures, and then the CESD-R assessment of depression. As previously noted, the RTS is a 20-item measure of 'global rumination,' while the RRS is a 20-item assessment of rumination as a coping mechanism for depression. The CESD-R is a 20-item assessment of depressive symptoms. A score less than 16 indicates no significant depressive symptoms, while a score greater than or equal to 16 indicates the presence of depressive symptoms (http://cesd-r.com/cesdr/). It is worth noting that only a clinical interview qualifies for a diagnosis of depression. After completing the surveys, participants completed the eight computerized selective attention tasks on a monitor approximately 44cm by 28cm, resolution 1680 by 1050. The non-emotional selective

attention tasks included a Stroop task, a negative priming task, a Flanker task, and finally a dot probe task. The emotional selective attention tasks followed the same structure as their non-emotional tasks, but used emotional stimuli, which were happy, sad, or neutral words or faces, as described below. Emotional words were drawn from the Affective Norms (ANEW; Bradley and Lang, 1999) database. Emotional faces were drawn from KEDF (Lundqvist et al., 1998; Oosterhof & Todorov, 2008) database. All tasks were participant-paced (within a 5000 ms response window before automatic progression) and featured 250 ms fixations. Intertrial intervals were between 250 ms and 1500 ms, depending on specific task. Participants were instructed to respond as rapidly and accurately as possible.

Stroop. The non-emotional Stroop task presented three color names (RED, GREEN, BLUE) in any of three display colors: green, blue, and red. Stimuli (Courier New, size 18 font, visual angle between 1.9 and 4.8 degrees) were centrally located, with one word presented per trial. Trial types included incongruent, congruent, and neutral trials. Incongruent trials were the color names presented in conflicting display colors (i.e., "RED" displayed in green). Congruent trials were color names presented in their respective display color (i.e., "RED" displayed in red). Neutral trials consisted of neutrally valenced words presented in any of the three display colors (i.e., "WOOL" in red). Participants had up to 5000 ms to respond and end the trial. Responses were via keys marked with the color of the stimulus. There were 1500 ms between each trial. This task consisted of three blocks, each with 126 trials, for a total of 378 trials. Within each block, there were 42 incongruent, 42 congruent, and 42 neutral trials, so there were 126 trials of each type, overall. Before completing the main task blocks, participants

completed a set of 25 practice trials to familiarize them with response mapping (10 trials) and the actual trials (15 trials). Note that, initially, the non-emotional Stroop effect was analyzed in terms of both the previously discussed fast and slow effects. The manipulation of interest for the fast effect is the median response time difference between incongruent trials following neutral trials and neutral trials following neutral trials. The manipulation of interest for the slow effect is the difference in median response time between neutral trials following incongruent trials and neutral trials following neutral trials. However, reliability analyses, discussed in depth in the results section, indicated that a traditional approach (i.e., taking the RT difference between neutral and incongruent trials) yielded a much more reliable measure.

Negative Priming. The non-emotional negative priming (NP) task displayed two of three letters: A, D, and S (Courier New, size 18 font, visual angle approximately 4.8 degrees across), presented in green or olive, on each trial. The target and distractor letters were arranged in a diagonal position around central fixation, such that one was always slightly above and to the left of fixation with the other to the right and below (as if there were a box around central fixation, with one letter in the upper left corner and the other in the lower right, visual angle approximately 1.9 degrees across the diagonal of this box). The position of the target relative to the distractor varied randomly from trial to trial (that is, on any given trial, the target could be in either corner with the distractor in the other). Participants were tasked with identifying the olive letter (the target) and ignoring the green letter (the distractor). Trials were either control or negative priming trials. In control trials, the currently displayed target letter was different from the immediately preceding distractor letter. In negative priming trials, the current target letter was the

same as the previous distractor letter. Stimuli remained on the screen until response, or for 5000 ms. There were 1500 ms between trials. Not counting the first trial in each block, there were 120 trials in each of 3 blocks, for a total of 360 trials. On 50% of trials, the target is above the distractor. The first block contained 75 control and 44 negative priming trials. The second block contained 87 control and 32 negative priming trials. The third block contained 75 control and 44 negative priming blocks. Before starting the main NP task blocks, participants completed 20 practice trials (10 response mapping trials followed by 10 practice trials). The manipulation of interest in the non-emotional negative priming task was the difference in median response time between negative priming and control trials.

Flanker. Each trial of the non-emotional Flanker task presented three words (Courier New, size 18 font, visual angle between approximately 1.9 and 4.8 degrees) in a vertical arrangement (spanning approximate visual angles 1.9 to 4.8 degrees wide by 2.4 degrees high, 2.9 to 4.8 degrees at the diagonal) in the center of the screen. The flankers were the two outermost words and appeared first. After a brief delay of 500 ms, the target word appeared in the center of the screen between the two flankers and remained until response or for 5000 ms. The presented words were either living or nonliving nouns or adjectives. Participants were tasked with identifying whether the central target was living (L) or not (N). In congruent trials, the flankers and target were all either living or nonliving. In incongruent trials, the flankers and target did not match on living versus nonliving. This resulted in two basic types of trials: congruent trials (i.e., NNN and LLL) and incongruent trials (i.e., LYL and YLY). There were three blocks of Flanker trials, each with 120 trials in each, for a total of 360 trials in the entire task. Within each block, there

were 30 trials of each trial type, so there were 90 trials of each type, total. Participants completed 20 practice trials (10 response mapping and 10 practice) before completing the main blocks of trials. The manipulation of interest in the non-emotional Flanker task is the difference in median response time between incongruent and congruent trials.

Non-emotional Dot Probe. Each trial of the Non-emotional dot probe presented two identical neutrally valenced faces (all faces were portraits, 281 by 381 pixels on the screen simultaneously, separated by approximately 9 degrees of visual angle. After 450 ms, one face flashed off for 100 ms before reappearing, then both faces remained on the screen for an additional 450 ms. Both faces were then replaced with a probe (*) centrally located behind one of the two faces. Participants had up to 5000 ms to identify whether the probe appeared on the left or the right side of the screen. Identical faces were used so that attentional capture could only be attributed to the flashing face manipulation. Incongruent trials occurred when the flashing face was on the opposite side of the screen from the subsequent probe, while congruent trials occurred when the flashing face appeared on the same side of the screen as the subsequent probe. There were three blocks with 120 trials in each block. Within each block, there were 60 congruent trials and 60 incongruent trials, for a total of 180 congruent and 180 incongruent trials, overall. Before completing the main block of trials, participants completed 25 practice trials (10 response mapping trials and 15 practice trials). The manipulation of interest is the median response time difference between incongruent and congruent trials.

Emotional Stroop. Each trial of the emotional Stroop task presented happy, sad, or neutral valence words from the ANEW, in red, green, or blue font. Stimuli (Courier New, size 18 font, visual angle between 1.9 and 4.8 degrees) were centrally located, with one word

presented per trial. Participants had up to 5000 ms to identify the color in which the word on each trial was presented. There were 1500 ms between trials. There were three blocks, with 126 trials per block, for a total of 378 total trials. Within each block, there were 42 each of happy, sad, and neutral words, for a total of 126 trials of each valence. Before completing the three main blocks of trials, participants completed 25 practice trials (10 response mapping and 15 practice). The emotional Stroop trials were analyzed in terms of fast and slow effects, as discussed previously. Specifically, there were four contrasts of interest: the fast effect of sad stimuli, the fast effect of happy stimuli, the slow effect of sad stimuli, and the slow effect of happy stimuli. The manipulation of interest for the sad fast effect was the difference in median response time between sad words following neutral words and neutral words following neutral words. The manipulation of interest for the fast effect of happy words was the difference in median response time between happy words following neutral words and neutral words following neutral words. The manipulation of interest for the slow effect of sad words was the median response time difference between neutral trials following sad trials and neutral trials following neutral trials. The manipulation of interest for the slow effect of happy words was the median response time difference between neutral trials following happy trials and neutral trials following neutral trials.

Negative Affective Priming. Each trial of the negative affective priming task presented participants with a pair of words (Courier New, size 18 font, visual angle 1.9 and 4.8 degrees), with the target and the distractor differentiated by color; the target was in olive and the distractor was in green. The target and distractor were arranged in a diagonal position around central fixation, such that one was always slightly above and to the left of

fixation with the other to the right and below (as if there were a box around central fixation, with one letter in the upper left corner and the other in the lower right, approximate visual angle between 3.8 and 5.7 degrees across the diagonal of this box). The position of the target relative to the distractor varied randomly from trial to trial (that is, on any given trial, the target could be in either corner with the distractor in the other). Participants had up to 5000 ms to indicate whether the valence of the target word was happy, sad, or neutral. There were three blocks, each with 120 trials, for a total of 360 trials in the task. In the first block, there were 77 control, 16 sad, 14 happy, and 12 neutral negative priming trials. In the second block, there were 87 control, 11 sad, 10 happy, and 11 neutral negative priming trials. In the third block, there were 75 control, 12 sad, 15 happy, and 16 neutral negative priming trials. On 50% of trials, the target was above the distractor, and the other 50% of trials had the target below the distractor. Before completing the main blocks of trials, participants performed 18 response mapping and 12 practice trials. There were two contrasts of interest in the negative affective priming task: the median response time difference between sad NP trials and control trials and the median response time between happy NP trials and control trials.

Emotional Flanker. Each trial of the Emotional Flanker task presented three words (Courier New, size 18 font, visual angle between 1.9 and 4.8 degrees) in a vertical column around the central fixation point (spanning approximate visual angles 1.9 to 4.8 degrees wide by 2.4 degrees high, 2.9 to 4.8 degrees at the diagonal) in the center of the screen. The two outermost words are the flankers, and the central word is the target. After the 250 ms fixation, the flankers appeared for 500 ms. After this brief delay, the central target word appeared between the two flankers. Participants had up to 5000 ms to identify

whether the target words were sad, neutral, or happy. There were 126 trials in each of three blocks, for a total of 378 trials. Trial types were a combination of the valences of the flankers and the target, and are as follows: HHH, HNH, HSH, NHN, NNN, NSN, SHS, SNS, and SSS. Within each block, there were 14 trials of each trial type, resulting in 42 trials of each type overall. Before completing the main blocks of trials, participants completed 25 practice trials (10 response mapping and 15 practice). There were two contrasts of interest in the emotional flanker task: the effect of sad distractors, isolated with the difference in median response times between SNS and NNN trials, and the effect of happy distractors, isolated with the median response time difference between HNH and NNN trials.

Emotional Dot Probe. Each trial of the Emotional dot probe task presented two faces (all faces were portraits, 281 by 381 pixels) on the screen simultaneously, separated horizontally by approximately 9 degrees of visual angle, for 1000 ms. After the faces disappeared, a probe (*) appeared centered behind one of the faces, and participants had 4000 ms to respond by identifying the side of the screen on which the probe appeared. There were six stimulus pairings, which are as follows: Happy-Neutral, Happy-Sad, Neutral-Happy, Neutral-Sad, Sad-Happy, and Sad-Neutral. The target probe appeared behind either the left or right face in each stimulus pair, with order randomized across blocks. There were 120 trials in each of three blocks, for a total of 360 trials overall. Within each block, there were 20 trials of each type, for a total of 60 trials of each type overall. Participants completed 25 practice trials (10 response mapping followed by 15 practice trials). There were two contrasts of interest in the emotional dot probe task: the difference in median response times between congruent and incongruent trials with happy

stimuli and the difference in median response times between congruent and incongruent trials with sad face stimuli.

CHAPTER 3

RESULTS

Median reaction times were computed for all task conditions, and difference scores were constructed for relevant contrasts. No contrasts between depressive and non-depressive mean median RTs were significant for any of the tasks (see Table 1). Cronbach's Alphas were computed for the planned difference scores using the three blocks for each task (see Table 1).

Table 1. Descriptive statistics for SA tasks (*N*=222).
Descriptive statistics are based on median reaction times. Means and standard deviations are shown for all task conditions and difference scores, for all participants, and split for participants scoring 16 or higher on the CESD-R (Depressive), and for participants scoring below 16 (Not Depressive).

		Total			Dep			Not Dep			Dep v. Not	
		Mean	SD	C's Alpha	Mean	SD	C's Alpha	Mean	SD	C's Alpha	*t*	*p*-value (2-tailed)
Non Emo Tasks												
Stroop	N	576.30	26.03		566.45	26.34		581.13	25.87		1.091	0.277
	I	628.61	36.95		621.25	40.74		632.22	35.09		0.611	0.542
	I-N	52.31	31.77	0.86	54.80	35.97	0.81	51.09	29.71	0.89	-0.425	0.671
Flanker	C	516.33	43.47		511.02	39.81		518.93	45.27		0.496	0.62
	I	626.61	48.76		615.84	47.90		631.89	49.18		0.921	0.358
	I-C	110.28	44.23	0.72	104.82	42.30	0.71	112.96	45.17	0.72	1.233	0.219
Negative Priming	Cn	591.85	30.63		590.88	31.20		592.33	30.35		0.118	0.907
	NP	627.70	34.82		631.08	34.44		626.04	35.01		-0.348	0.728
	NP-Cn	-17.83	48.15	-0.11	-18.60	52.55	-0.32	-17.46	46.00	0.01	0.341	0.734
Dot Probe	C	400.03	18.52		391.60	18.42		404.16	18.57		1.628	0.105
	I	394.06	19.00		383.76	19.13		399.11	18.94		1.898	0.059
	I-C	-5.97	14.27	0.36	-7.84	14.20	-0.09	-5.05	14.30	0.46	1.557	0.121

		Total			Dep			Not Dep			Dep v. Not	
		Mean	SD	C's Alpha	Mean	SD	C's Alpha	Mean	SD	C's Alpha	*t*	*p*-value (2-tailed)

Emo Tasks												
Emo Stroop	N	539.82	25.44		535.41	22.91		541.97	26.68		0.507	0.612
	H	539.78	23.86		532.29	24.40		543.44	23.59		0.648	0.518
	S	525.23	23.46		520.00	26.95		527.79	21.75		0.876	0.382
	S-N	-0.04	24.56	0.51	-3.12	23.72	0.55	1.47	24.97	0.48	1.308	0.192
	H-N	-14.59	23.96	0.58	-15.41	26.21	0.59	-14.19	22.86	0.57	0.331	0.741
Emo Flanker	NNN	723.99	95.12		720.86	86.70		725.52	99.24		0.157	0.875
	SNS	835.49	102.20		831.53	101.95		837.43	102.33		0.198	0.843
	HNH	798.89	96.27		801.03	89.63		797.84	99.52		-0.113	0.91
	SNS-NNN	111.50	113.70	0.45	110.67	112.83	0.49	111.91	114.13	0.43	0.091	0.927
	HNH-NNN	74.91	107.58	0.27	80.18	106.40	0.30	72.32	108.16	0.27	-0.637	0.525
Emo NP	Cn	973.50	69.69		961.74	65.30		979.26	71.85		0.556	0.579
	S	1005.41	104.12		994.98	90.34		1010.52	110.88		0.478	0.633
	H	989.83	121.35		965.58	112.22		1001.71	125.82		1.088	0.278
	N	1015.65	124.84		1015.86	127.92		1015.55	123.33		-0.009	0.993
	S-Cn	31.91	97.59	0.07	33.24	92.92	0.12	31.26	99.88	0.04	-0.199	0.842
	H-Cn	16.33	101.07	-0.10	3.84	95.13	-0.01	22.45	103.98	-0.18	1.958	0.051
	N-Cn	42.15	106.69	0.34	54.12	106.55	0.41	36.29	106.75	0.29	-1.364	0.174
Emo	CS	406.99	61.63		400.88	63.81		409.99	60.52		1.035	0.302

Dot Probe												
	IS	406.91	67.27		401.74	77.49		409.44	61.78		0.801	0.424
	CH	401.47	64.63		396.22	65.61		404.04	64.21		0.847	0.398
	IH	401.28	61.79		396.18	63.52		403.78	60.99		0.861	0.39
	IS-CS	-0.08	25.33	-0.39	0.86	29.83	-0.17	-0.55	22.90	-0.57	-0.386	0.7
	IH-CH	-0.19	-0.08	-0.12	-0.04	16.27	-0.87	-0.26	25.32	0.03	-0.069	0.945

Only non-emotional (cognitive) Stroop, non-emotional (cognitive) Flanker had Cronbach's Alphas in excess of 0.7 (0.86 and 0.72, respectively). Non-emotional (cognitive) Dot Probe (0.36), Sad Emotional Stroop (0.51), Happy Emotional Stroop (0.58), Neutral NAP (0.34), Sad Emotional Flanker (0.45), and Happy Emotional Flanker (0.27) had Cronbach's Alphas above 0.2. All other tasks had Cronbach's Alphas below 0.2 and were excluded from final analyses. The survey measures of depression and rumination are shown in Table 2.

Table 2. Descriptive statistics for questionnaires

Surveys			
Questionnaire	Mean	SD	Cronbach's Alpha
RTS	83.6103	16.53953	0.844
RRS-R	9.973	3.53383	0.747
RRS-B	10.2691	3.33667	0.753
RRS-D	25.1081	6.93454	0.846
CESD-R	13.9626	8.81259	0.723

All survey measures had Cronbach's Alphas above 0.7. Principal Components Analysis (PCA) was conducted using SPSS for all planned difference scores (scree plot in Figure 1 and structure matrix in Table 3), and then for only difference scores with Cronbach's Alphas exceeding 0.20 (scree plot in Figure 2 and structure matrix in Table 4).

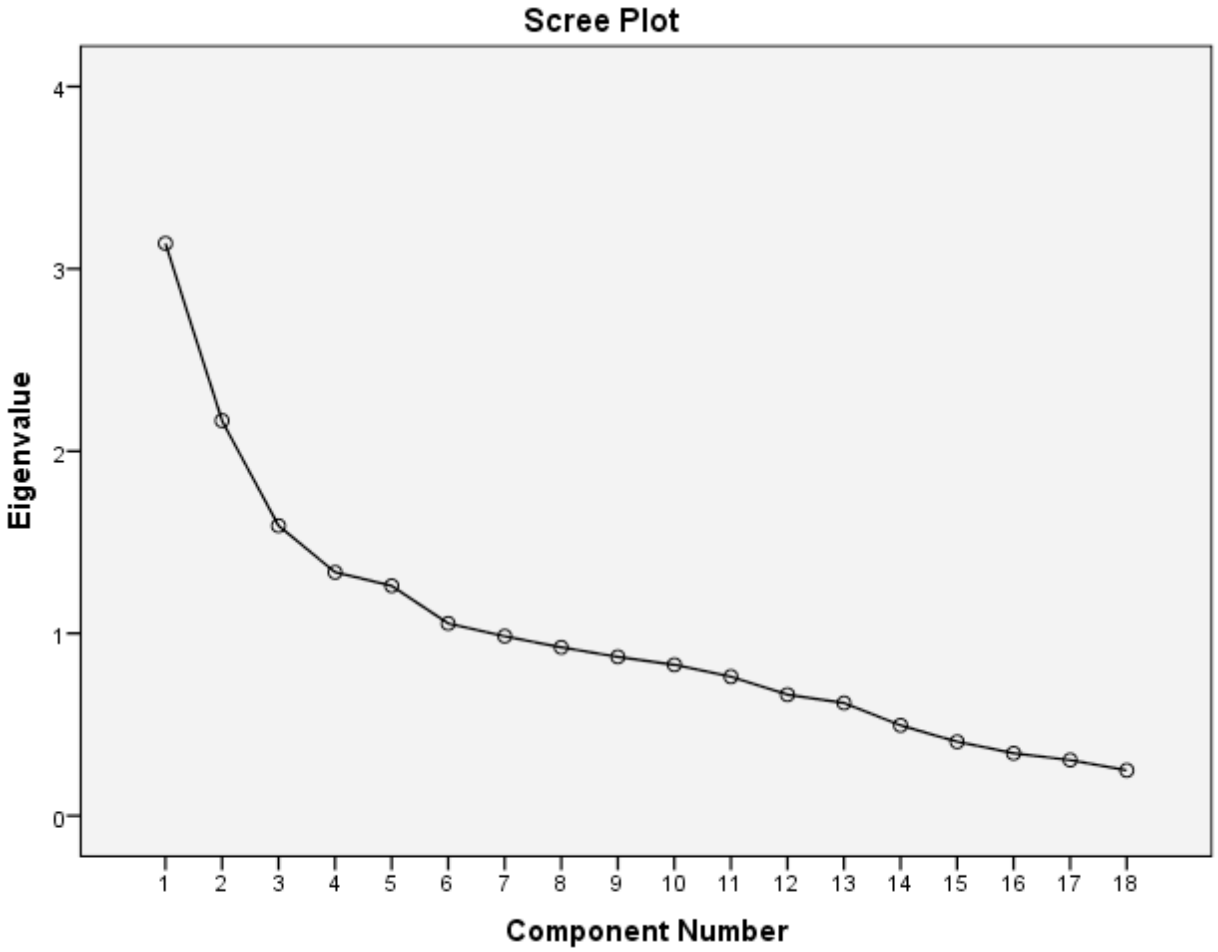

Figure 1. Scree plot for all planned difference scores *N*=222. The scree plot for all planned difference scores from a correlation-based principal components analysis, with an oblimin rotation, of all subjects (*N*=222). Values below 0.30 are omitted.

Table 3. Structure matrix of all planned difference scores. The structure matrix for all planned difference scores from a correlation-based principal components analysis, with an oblimin rotation, of all subjects (*N*=222). Values below 0.30 are omitted.

	Component					
	1	2	3	4	5	6
CESD-R	0.785					
RRS-D	0.865					
RRS-B	0.819					
RRS-R	0.735					
RTS	0.649					
Stroop				0.72		
NP			0.327		-0.583	
Flanker		0.561		-0.44		
Dot Probe					0.769	
Emo Stroop Sad			0.849			
Emo Stroop Happy			0.826			
NAP Sad		0.353				0.539
NAP Happy				-0.644		
NAP Neutral				0.411		
Emo Flanker Sad		0.879				
Emo Flanker Happy		0.864				
Emo DP Sad						0.542
Emo DP Happy						-0.62

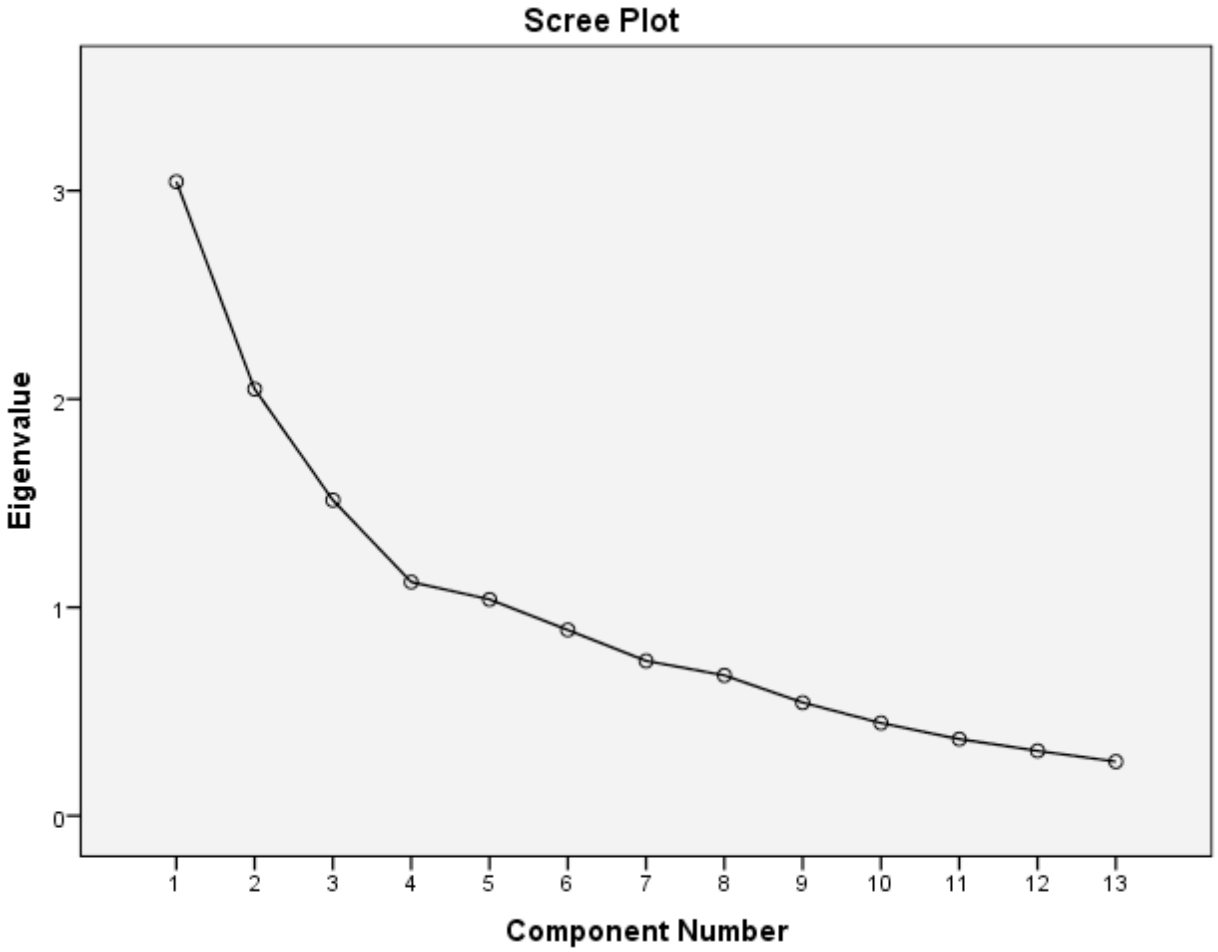

Figure 2. Scree plot for difference scores with Cronbach's Alpha > 2.0. The scree plot for only difference scores with Cronbach's Alphas greater than 0.2 from a correlation-based principal components analysis, with an oblimin rotation, of all subjects (*N*=222). Values below 0.30 are omitted.

Table 4. Structure matrix for difference scores with Cronbach's Alpha > 2.0. The structure matrix for only difference scores with Cronbach's Alphas greater than 0.2 from a correlation-based principal components analysis, with an oblimin rotation, of all subjects (*N*=222). Values below 0.30 are omitted.

	Component				
	1	2	3	4	5
CESD-R	0.79				
RRS-D	0.865				
RRS-B	0.822				
RRS-R	0.734				
RTS	0.657				
Stroop				0.853	
Flanker		0.569		-0.395	-0.304
Dot Probe					-0.878
Emo Stroop Sad			0.858		
Emo Stroop Happy			0.86		
NAP Neutral				0.528	0.414
Emo Flanker Sad		0.885			
Emo Flanker Happy		0.886			

Extraction was based on eignevalues greater than or equal to 1.0. A standard direct Oblimin rotation was used (Delta = 0). Briefly, all self-report measures formed a single component, while the selective attention (SA) task difference scores fell out much more sporadically. Since the CESDR, the RTS, and the subsets of the RRS all formed a single, strongly unified factor, we were unable to differentiate between types of rumination. Nor were we able to differentiate between depression (as assessed by the CESDR) and rumination based on these PCA's. Regarding the individual SA task difference scores a single Flanker component clearly emerged, regardless of the happy and sad valenced stimuli in the emotional task. However, separate non-emotional (cognitive) and emotional components emerged such that non-emotional Stroop and neutral Negative Affective Priming (NAP) formed their own component, while the sad and happy valenced emotional Stroops formed a single component of their own.

Based on these results from the second PCA, structural equation models were constructed to examine whether reaction times on non-emotional and emotional selective attention tasks were predictive of scores on the self-report measures of rumination and depression. The first model (Model 1, see Figure 3) fit a cognitive factor (composed of non-emotional Stroop and neutral NAP), a Flanker factor (composed of non-emotional and emotional Flankers), and an emotional Stroop factor, and used these to predict depression via a general rumination factor (composed of RTS and all three subsets of the RRS).

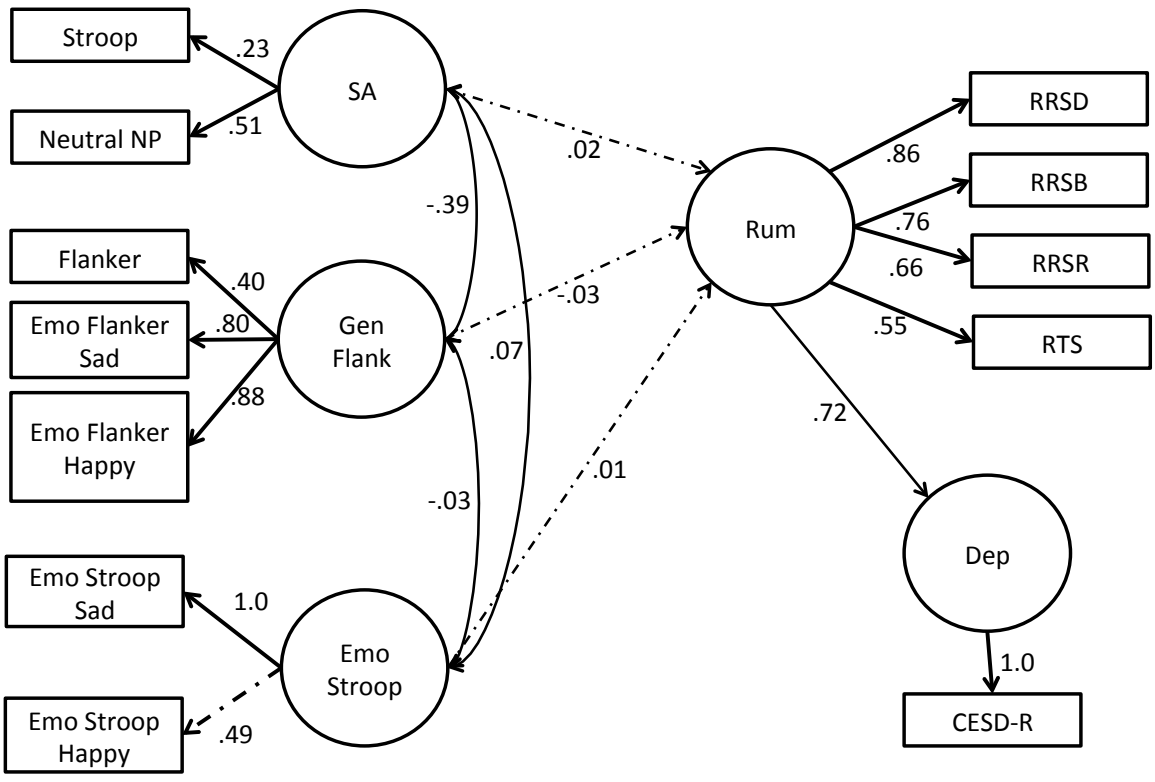

Figure 3. Model 1. Latent variable model, based on all participants (*N*=222), predicting depression (Dep) via rumination (Rum) from a non-emotional cognitive factor (composed of Stroop and Neutral Negative Priming). RMSEA = 0.04, CFI = 0.97, Chi-Square(47) = 65.49, Model AIC = -28.51. Dotted lines represent paths that were not significant at Alpha = 0.05.

This model fit the data somewhat well, RMSEA = 0.04, CFI = 0.97, Chi-Square(47) = 65.49, Model AIC = -28.51. However, Neutral NAP failed to load significantly at Alpha = 0.05 on the general cognitive factor, and both valences of emotional Stroop failed to load significantly on their factor as well. Model 2 (see Figure 4) was constructed by omitting these variables.

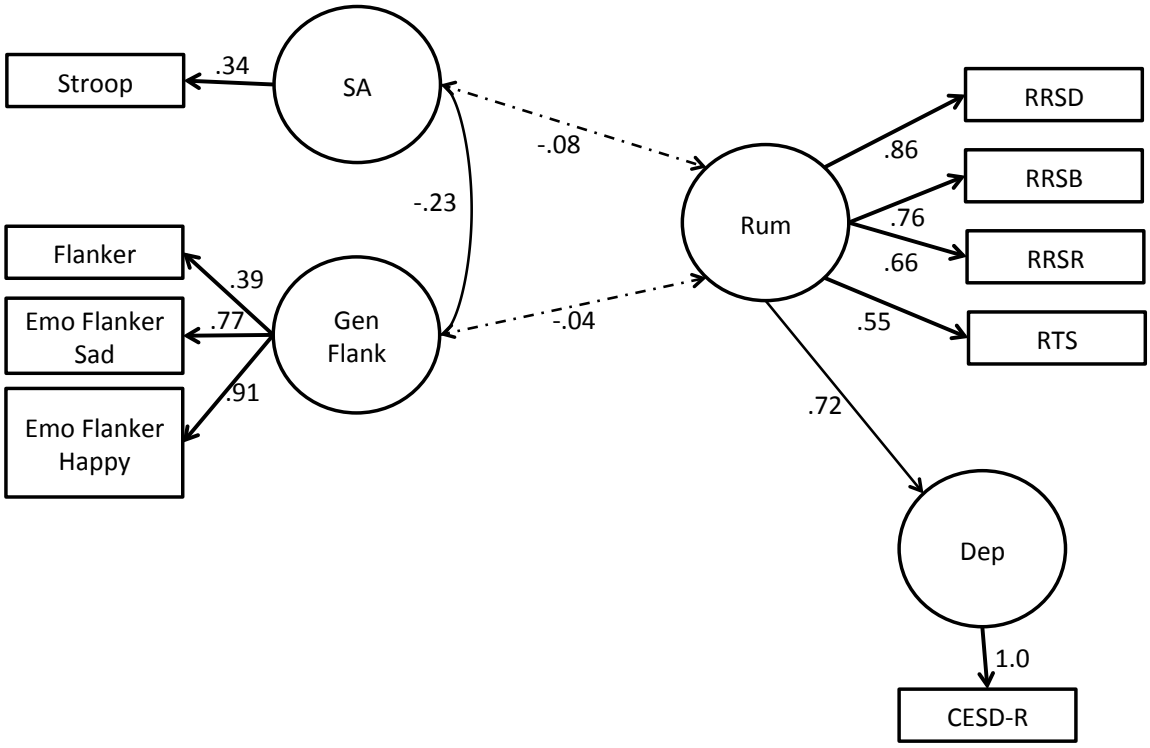

Figure 4. Model 2.
Latent variable model, based on all participants (*N*=222), predicting depression (Dep) via rumination from non-emotional Cognitive Stroop and a general Flanker factor (composed of non-emotional Flanker, sad-valenced emotional Flanker, and happy-valenced emotional Flanker tasks). RMSEA = 0.05, CFI = 0.98, Chi-Square(23) = 35.87, Model AIC = -10.13 Dotted lines represent paths that were not significant at Alpha = 0.05.

Model 2 used non-emotional Stroop and a general Flanker factor, composed of non-emotional, sad, and happy Flanker trials, to predict scores on the CESD-R via a general rumination factor, composed of scores on the RTS and the three subsets of the RRS. This model also fit the data fairly well, RMSEA = 0.05, CFI = 0.98, Chi-Square(23) = 35.87, Model AIC = -10.13, and all loadings were significantly different from zero at Alpha = 0.05. However, neither the SA factors in Model 1 nor in Model 2 significantly predicted the rumination and depression factors. Rumination was predictive of Depression in both models with a path equal to 0.72.

CHAPTER 4

DISCUSSION

The current study set out to examine the relationship among depression, rumination, and selective attention, for both emotionally valenced and neutral stimuli, from a latent variables perspective. Nonclinical depression was assessed using the CESDR, which flagged 74 participants as depressive, out of 222 participants overall. A general non-emotional attention latent construct did not coalesce, nor did a general emotional attention construct. Instead, for the Flanker tasks, trials from the non-emotional task version formed a factor along with sad and happy valenced trials from the emotional version of the task. That is, the sad and happy trials did not behave differentially from the neutral trials, indicating that valence was not a relevant component, at least within the Flanker task. The Stroop tasks did not mirror this result, with the non-emotional, cognitive Stroop preferring to form its own factor separate from the emotional variants of Stroop, which wanted to create their own factor (although these loadings were not significantly different from zero at Alpha = 0.05). Overall, I did not observe a causal relationship from attention, neither emotional nor non-emotional, to rumination and depression. Additionally, global rumination was largely undifferentiated from coping rumination in the current study.

Furthermore, as shown in Table 1, many of the literature's established emotional selective attention tasks failed to meet a minimal reliability threshold of Cronbach's Alpha of at least 0.7 (Lance, Butts, and Michels, 2006), regardless of whether all subjects were included in the analyses or depressive and non-depressive subjects were analyzed separately. Only the traditional, non-emotional cognitive Stroop task and non-emotional

Flanker task, produced effects above this threshold. The negative priming tasks were spectacularly unreliable, both non-emotional and negative affective priming. All observed variants of the dot probe task were similarly unreliable, and the emotional Stroop tasks also fell somewhat below threshold. Some of these issues with reliability are not entirely unexpected. Friedman and Miyake (2004) suggested caution in the use of negative priming as a measure of individual differences in inhibitory functioning. Zetsche and Joormann (2011) only found that NAP was predictive of both rumination and depression only at the end of a longitudinal study; at the beginning, the NAP was only predictive of depression. Adding to this, their emotional flanker task predicted rumination but not depression during the initial session of their study. Nee and Jonides (2008) found that negative priming was reasonably related to resistance to proactive interference. Similarly, an evaluation of the reliability of the dot probe task conducted by Schmukle (2005) found that it had low reliability in a non-clinical sample of anxious individuals. Only in clinical samples was it a reliable measure of attentional allocation (for physical threats, retest reliability was between -0.22 and 0.32; Schmukle, 2005). However, in the current study, Cronbach's Alpha values were similar regardless of whether all participants or only those with CESD-R scores greater than or equal to 16 were included in the analyses. Nevertheless, an additional PCA, utilizing the same extraction criteria and rotation as the previous PCAs, was conducted solely on the depressive participant subset (see Figure 5 for the scree plot and Table 5 for the structure matrix).

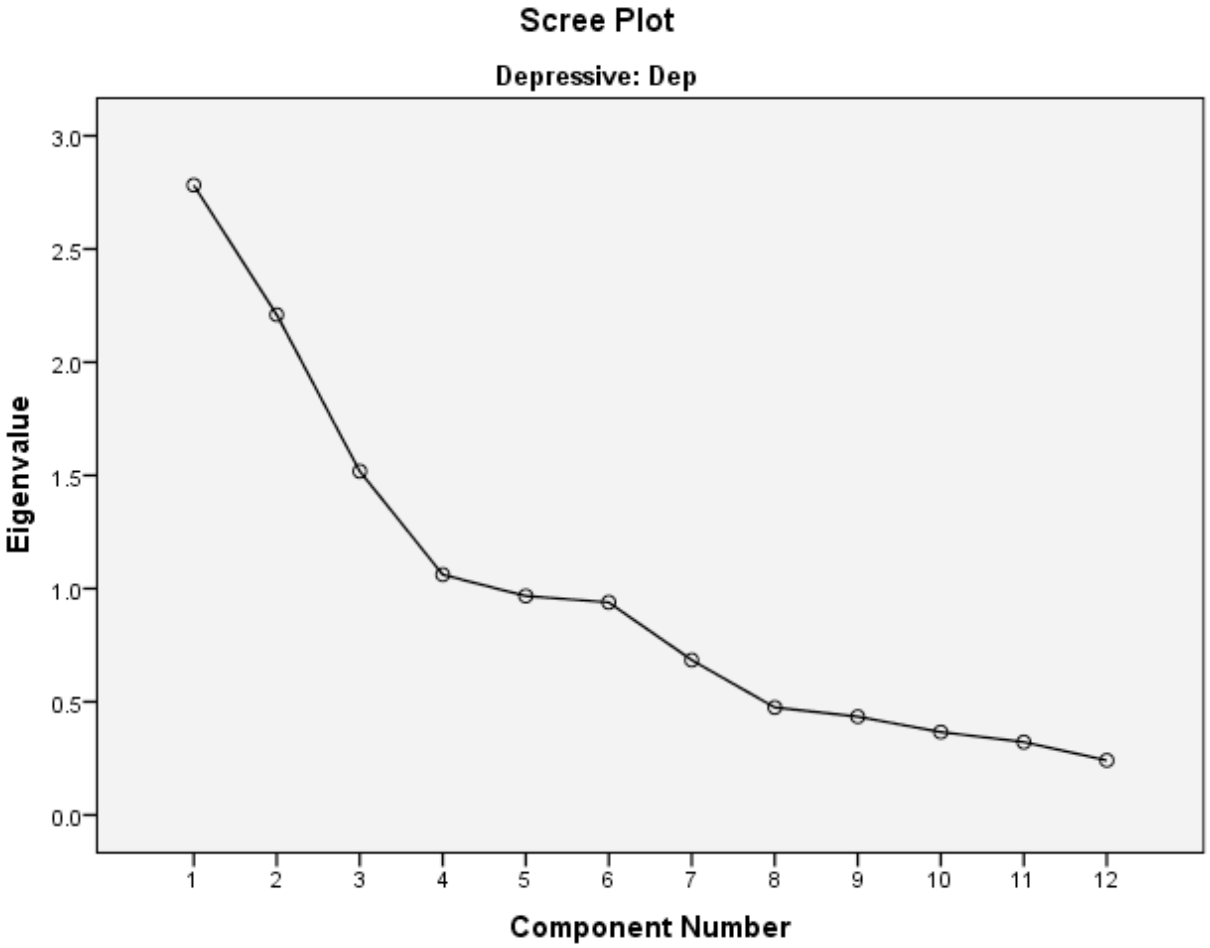

Figure 5. Scree plot for difference scores with Cronbach's Alpha > 2.0. Depressive subjects only.The scree plot for only difference scores with Cronbach's Alphas greater than 0.2 from a correlation-based principal components analysis, with an oblimin rotation, of depressive subjects only (*N*=73). Values below 0.30 are omitted.

Table 5. Structure matrix for difference scores with Cronbach's Alpha > 2.0. Depressive subjects only. The structure matrix of difference scores with Cronbach's Alphas greater than 0.2 from a correlation-based principal components analysis, with an oblimin rotation, conducted only on subjects with CESD-R scores greater than or equal to 16 (*N*=73). Values below 0.30 are omitted.

	Component			
	1	2	3	4
CESD-R	0.816			
RRS-D	0.762			
RRS-B	0.813			
RRS-R	0.783			
RTS	0.397			
Stroop				0.909
Flanker		0.656		
Emo Stroop Sad			0.826	0.331
Emo Stroop Happy			0.861	
NAP Neutral		-0.409		
Emo Flanker Sad		0.868		
Emo Flanker Happy		0.819		

This PCA included only difference scores for tasks with Cronbach's Alphas at or above 0.2 (see Table 1 for reliability data). The results of this PCA were used to inform the creation of two new latent variable models (3 and 4). Model 3, shown in Figure 6, attempted to predict rumination using non-emotional Stroop, a general Flanker factor (composed of non-emotional Flanker, sad-valenced emotional Flanker and happy-valenced emotional Flanker trials), and emotional Stroop (composed of sad and happy distractor trials).

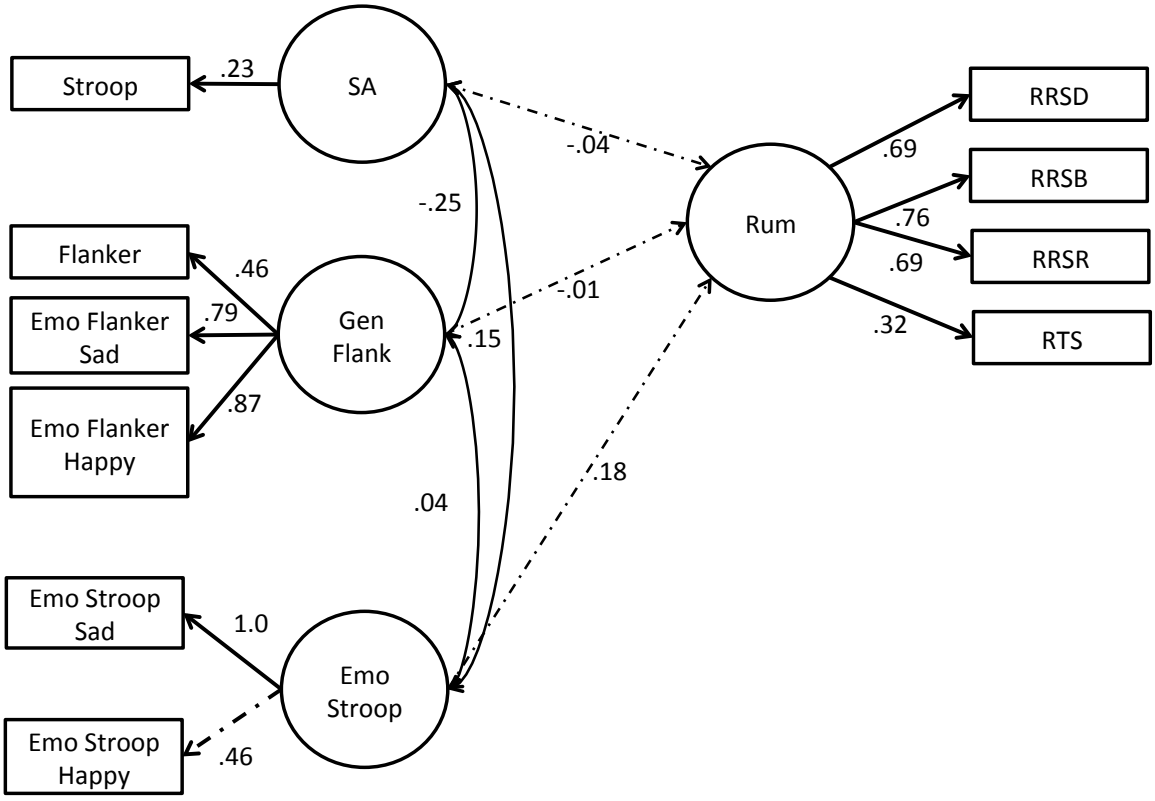

Figure 6. Model 3. Latent variable model, based only on depressive participants (*N*=73), predicting rumination from non-emotional Cognitive Stroop, a general Flanker factor (composed of non-emotional Flanker, sad-valenced emotional Flanker, and happy-valenced emotional Flanker trials), and emotional Stroop (composed of sad and happy stimulus trials). RMSEA = 0.01, CFI = 1.00, Chi-Square(29) = 29.19, Model AIC = -28.81. Dotted lines represent paths that were not significant at Alpha = 0.05.

This model fit the data fairly well, RMSEA = 0.01, CFI = 1.00, Chi-Square(29) = 29.19, Model AIC = -28.81. However, the factor loadings for the non-emotional Stroop tasks were not significant at Alpha=0.05, so they were removed, resulting in Model 4 (shown in Figure 7).

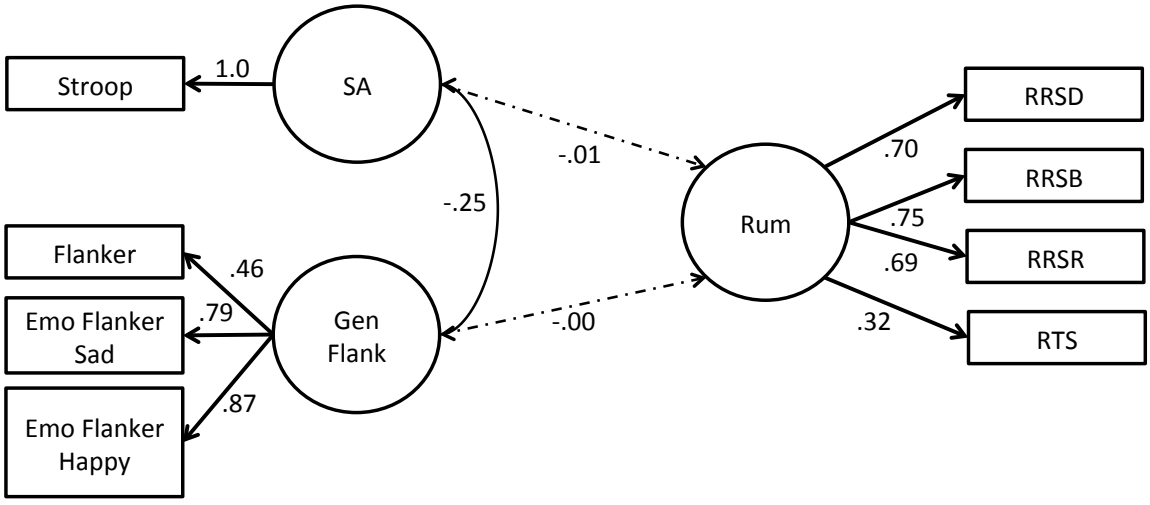

Figure 7. Model 4. Latent variable model, based only on depressive participants (*N*=73), predicting rumination from non-emotional Cognitive Stroop and a general Flanker factor (composed of non-emotional Flanker, sad-valenced emotional Flanker, and happy-valenced emotional Flanker trials). RMSEA = 0.05, CFI = 0.98, Chi-Square(17) = 19.76, Model AIC = -14.244. Dotted lines represent paths that were not significant at Alpha = 0.05.

Model 4 sought to predict rumination using only non-emotional Stroop and the same general Flanker factor from Model 3. This model also fit the data fairly well, RMSEA = 0.05, CFI = 0.98, Chi-Square(17) = 19.76, Model AIC = -14.244. All factor loadings were significant at Alpha=0.05, but for both Models 3 and 4, the paths predicting rumination from the selective attention factors were not different from zero at Alpha=0.05. In short, examining only depressive participants did not produce differential results from those obtained when the entire sample was utilized.

Another potential concern is that the median RTs for many of the measures in the current study fall roughly between 500 and 600 ms, which could be driving the low task correlations via restriction of range, which in turn damage the applicability of latent variables analysis. Finally, tasks such as Stroop require that difference scores be analyzed to isolate the effect of interference. Difference scores are inherently unreliable (Cronbach and Furby, 1970) but are commonly used when assessing selective attention and inhibition in the context of depression and rumination.

To reiterate, the present study did not find selective attention tasks, cognitive nor emotional, to be predictive of rumination and depression. None of the emotional tasks included in this study produced effects with Cronbach's Alphas above 0.70, with only the non-emotional Stroop and Flanker tasks exceeding this threshold. Furthermore, existing self-report measures of rumination may not be satisfactorily free from depressive items, as the more recent RTS, purported to be a measure of global rumination, formed a single factor with all three subsets of the RRS (depressive, brooding, and reflective). In this study, rumination formed a construct largely undifferentiated by whether or not it was framed as a response to depression or a general tendency to repetitively process information. One's ability to control one's attention seems to be unrelated both to one's tendency to ruminate and to one's tendency to suffer from depressive symptoms.

CHAPTER 5

AUTHOR NOTE

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